

August 1996 Preliminary Data Summary

by Field Research Facility

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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal and Hydraulics Laboratory's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

Data from these reports are now available via the World Wide Web at <http://www.frf.usace.army.mil>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Please note the new web address, <http://www.frf.usace.army.mil>

Your comments and criticisms are welcome.

Introduction

1

The U.S. Army Engineer Waterways Experiment Station, Coastal and Hydraulic Laboratory's (CHL) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511 (*c.baron@cerc.wes.army.mil*).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to Eastern Standard Time (EST).

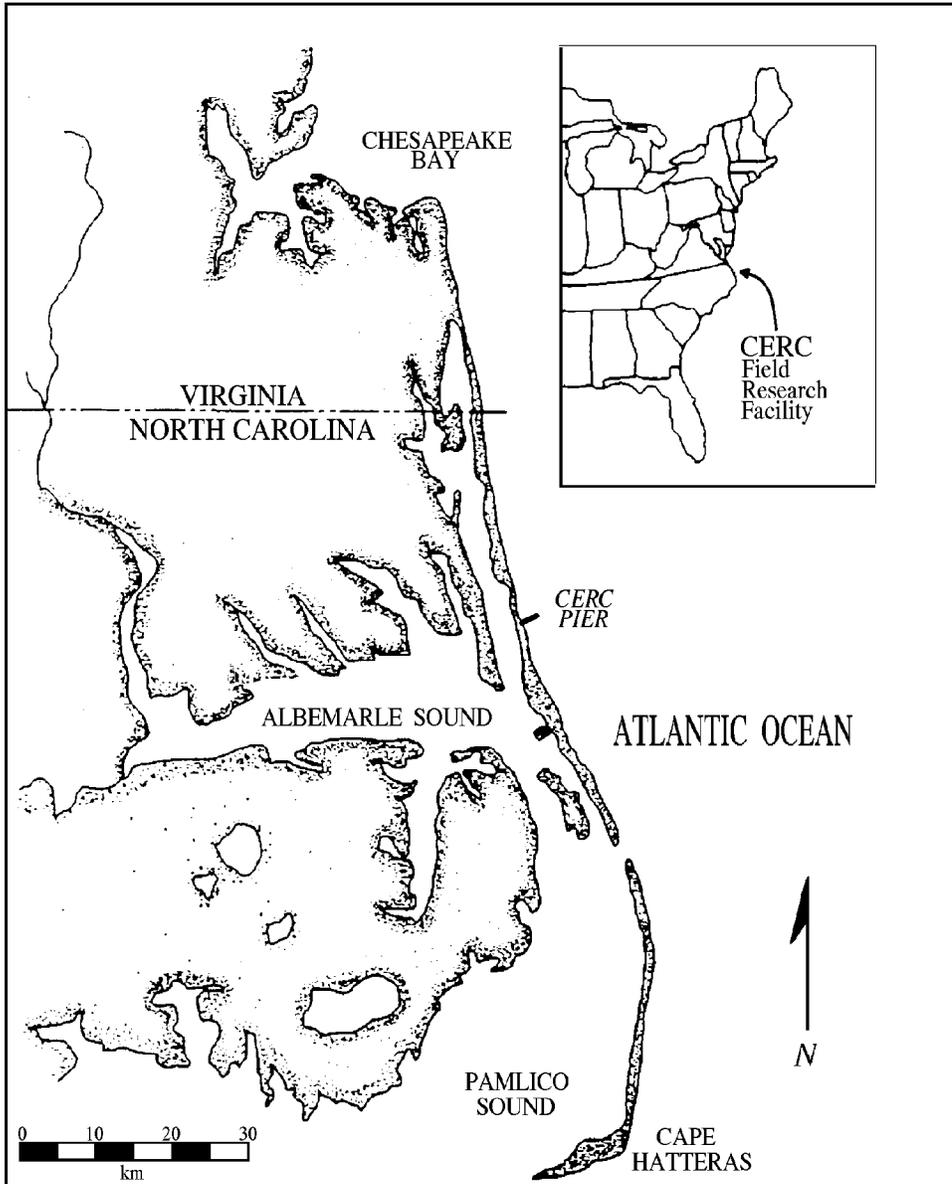


Figure 1. FRF Location Map

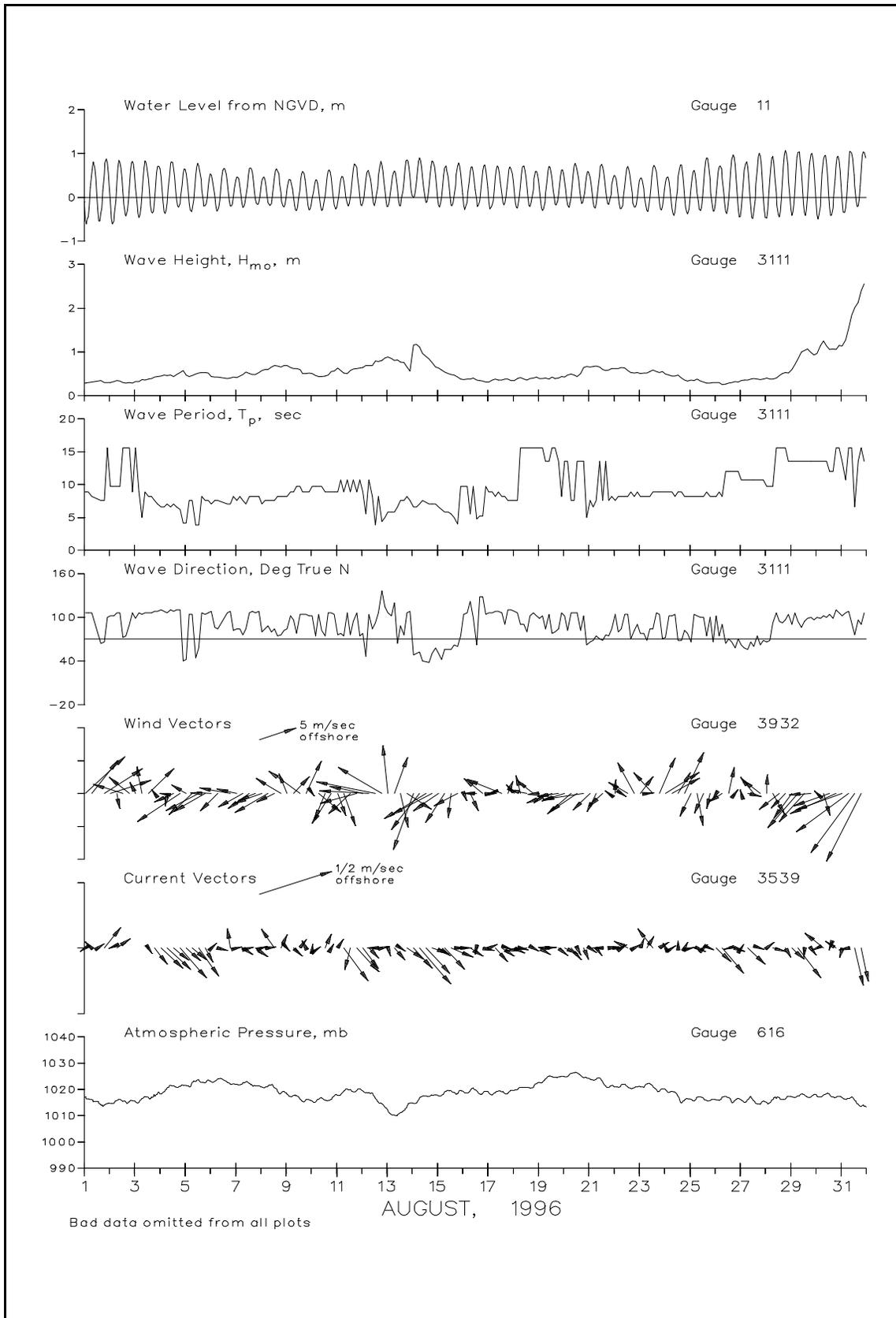


Figure 2. Month at a Glance

**Table 1
Instrument Status/Data Availability**

		August 1996																																		
		Day of the month																																		
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	/	/	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	*	*	*			
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
Gauge Status			*	/	-																															
Data Collected			*	/	-																															
Visual Observations			*	/	-																															

**Table 2
Gauge Locations**

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates *Crossshore m	Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	----	----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62
R		R	R	R	R	R	R

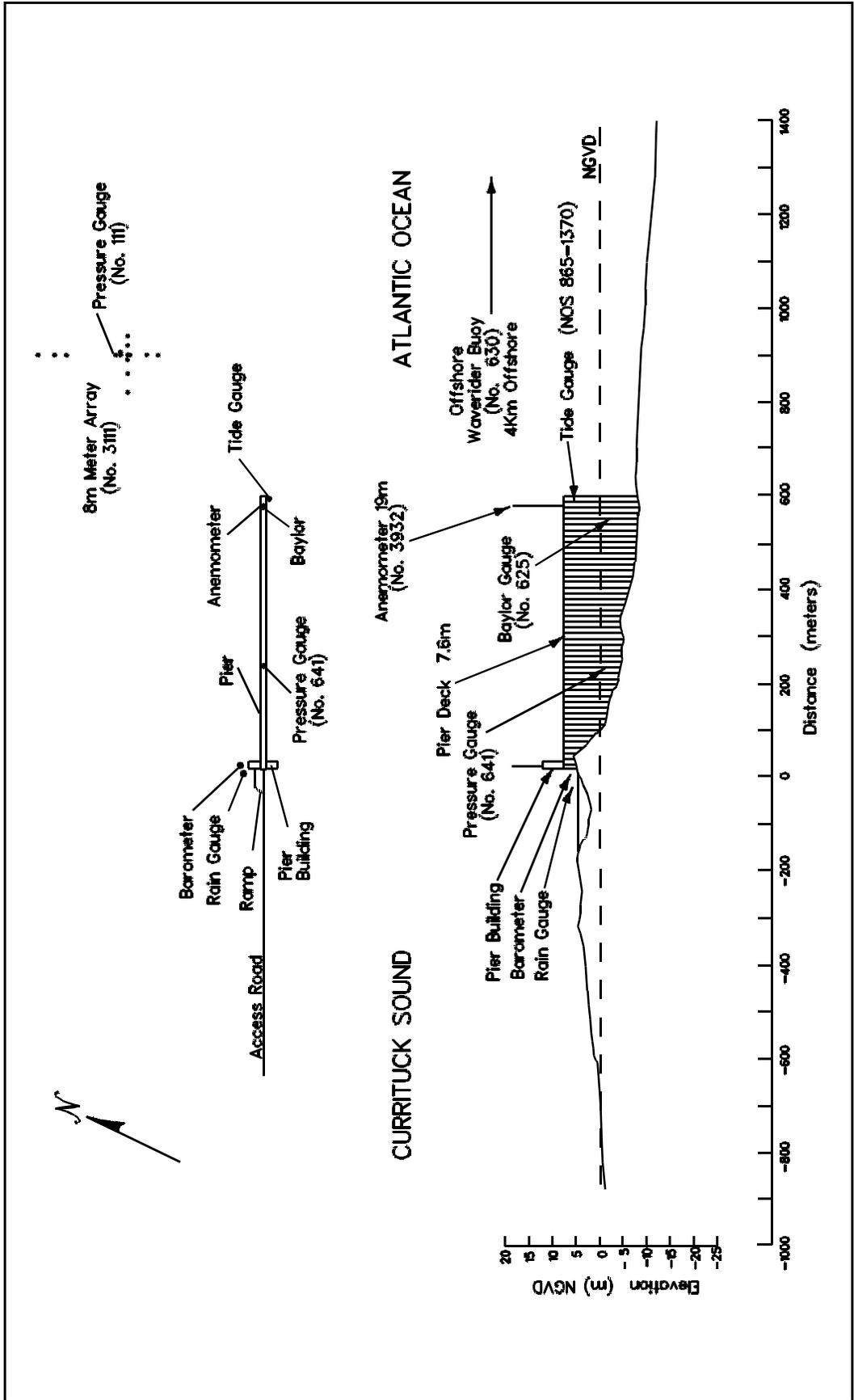


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

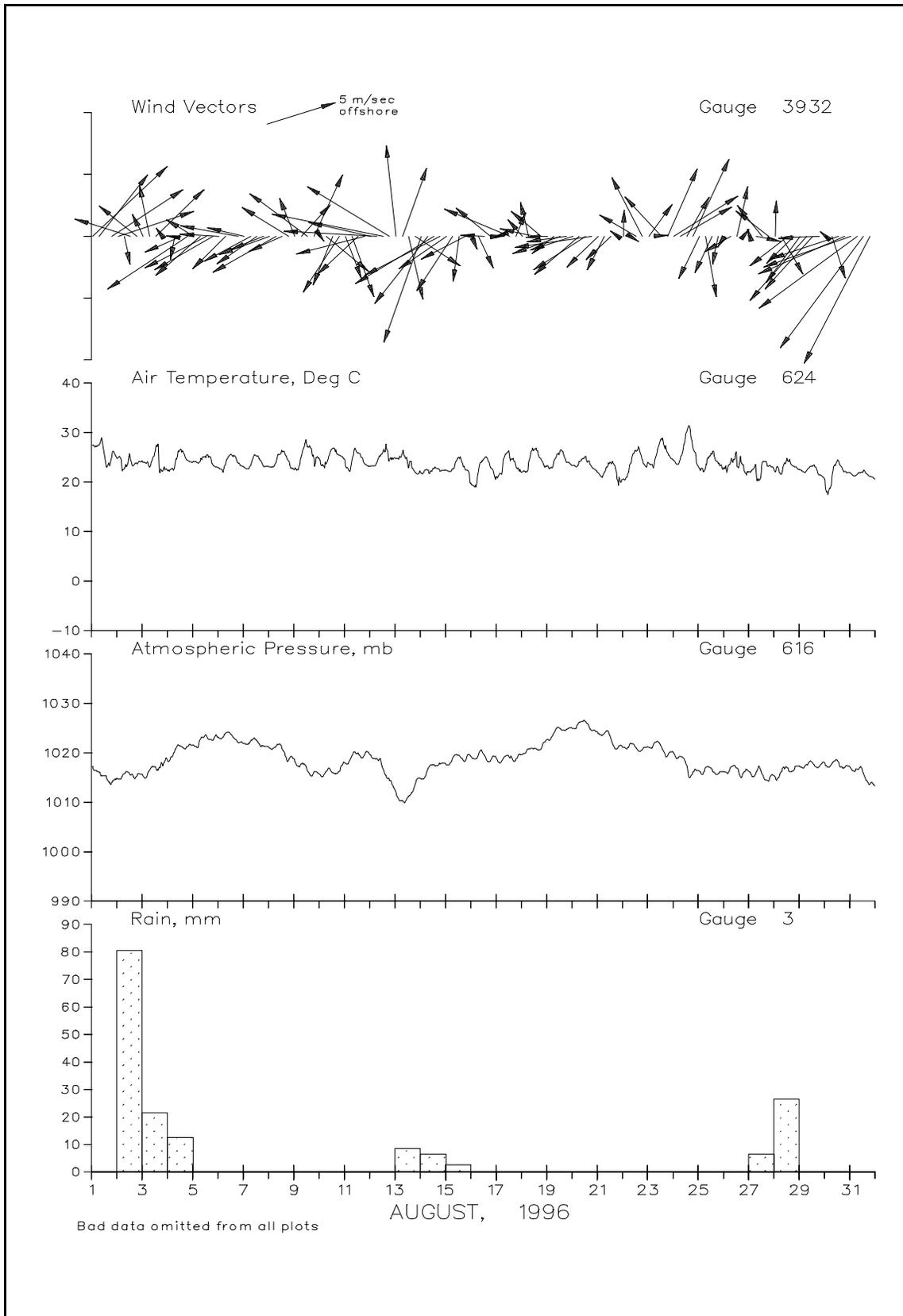


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Aug 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	8	222	27.4	1017.3	0
	700	6	214	27.5	1016.2	0
	1300	8	192	23.2	1015.6	0
	1900	6	232	25.0	1014.1	0
2	100	6	249	24.9	1014.7	0
	700	2	1	22.7	1015.8	80
	1300	4	109	24.6	1015.5	0
	1900	4	132	23.7	1015.3	0
3	100	2	156	24.0	1015.3	0
	700	4	170	23.0	1016.6	22
	1300	5	221	26.9	1017.0	0
	1900	1	146	22.2	1017.8	0
4	100	0		22.4	1018.3	0
	700	2	9	23.5	1020.7	13
	1300	3	62	26.6	1021.4	0
	1900	7	52	24.4	1021.3	0
5	100	2	124	24.1	1021.5	0
	700	4	44	24.2	1022.8	0
	1300	5	58	25.3	1023.6	0
	1900	5	56	23.5	1022.6	0
6	100	3	92	22.8	1022.9	0
	700	3	1	23.6	1024.0	0
	1300	2	55	25.6	1024.5	0
	1900	4	101	23.8	1022.0	0
7	100	3	104	23.0	1021.9	0
	700	4	57	23.4	1022.5	0
	1300	4	51	25.2	1022.5	0
	1900	3	64	23.2	1021.4	0
8	100	4	66	23.1	1021.0	0
	700	5	56	24.0	1021.3	0
	1300	3	61	26.1	1020.8	0
	1900	4	125	24.2	1018.6	0
9	100	3	160	22.6	1018.3	0
	700	3	218	25.2	1017.8	0
	1300	5	130	27.1	1016.4	0
	1900	5	202	24.7	1016.2	0
10	100	0		24.4	1015.6	0
	700	4	314	23.6	1016.3	0
	1300	4	19	26.9	1016.0	0
	1900	5	28	25.4	1016.2	0

**Table 3
Meteorological Data (continued)**

Aug 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	4	342	23.2	1017.9	0
	700	5	342	24.5	1019.4	0
	1300	4	42	25.9	1020.0	0
	1900	5	72	23.7	1019.7	0
12	100	4	104	23.2	1019.6	0
	700	7	93	23.9	1018.9	0
	1300	8	102	26.3	1016.7	0
	1900	7	124	24.5	1014.4	0
13	100	7	174	24.7	1012.0	0
	700	6	197	26.0	1010.4	9
	1300	5	348	22.9	1011.3	0
	1900	4	307	21.9	1013.6	0
14	100	9	16	21.7	1014.7	0
	700	7	34	22.4	1016.8	6
	1300	7	54	22.8	1017.7	0
	1900	6	59	22.2	1017.8	0
15	100	4	51	22.3	1017.6	0
	700	5	29	22.7	1019.0	2
	1300	4	6	24.9	1019.5	0
	1900	4	58	22.5	1018.4	0
16	100	1	341	19.4	1019.1	0
	700	3	337	22.1	1019.6	0
	1300	2	91	24.8	1019.5	0
	1900	3	132	22.9	1018.5	0
17	100	0		20.9	1018.7	0
	700	0		24.5	1018.9	0
	1300	5	115	24.9	1019.0	0
	1900	2	199	23.2	1018.8	0
18	100	2	143	22.0	1019.7	0
	700	3	168	23.9	1020.8	0
	1300	2	103	26.7	1020.9	0
	1900	3	133	24.4	1020.9	0
19	100	2	85	23.2	1022.7	0
	700	2	47	24.2	1024.0	0
	1300	4	66	26.4	1024.9	0
	1900	3	80	24.0	1024.8	0
20	100	3	69	23.4	1024.9	0
	700	4	45	24.2	1026.2	0
	1300	5	53	25.2	1026.3	0
	1900	5	80	23.1	1024.5	0

**Table 3
Meteorological Data (concluded)**

Aug 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	3	41	21.8	1023.9	0
	700	3	23	21.9	1024.0	0
	1300	3	42	23.9	1022.9	0
	1900	1	131	20.6	1020.9	0
22	100	2	181	20.7	1021.1	0
	700	1	306	23.5	1021.8	0
	1300	3	123	26.2	1021.1	0
	1900	5	155	24.5	1020.6	0
23	100	3	212	23.8	1021.1	0
	700	1	264	24.6	1022.1	0
	1300	4	141	28.8	1021.2	0
	1900	6	200	25.9	1019.4	0
24	100	5	233	24.4	1019.9	0
	700	4	236	24.7	1019.3	0
	1300	4	206	30.2	1017.5	0
	1900	7	201	26.9	1016.1	0
25	100	4	22	22.8	1016.4	0
	700	5	351	22.9	1017.1	0
	1300	3	21	25.6	1016.6	0
	1900	2	10	23.8	1015.9	0
26	100	1	28	22.7	1016.2	0
	700	2	55	24.1	1017.1	0
	1300	4	190	23.2	1017.0	0
	1900	1	214	23.4	1015.9	0
27	100	1	165	22.1	1016.2	0
	700	2	284	22.1	1016.2	7
	1300	3	144	24.0	1015.7	0
	1900	3	131	23.2	1014.3	0
28	100	3	181	22.1	1015.1	0
	700	3	334	21.5	1016.2	27
	1300	4	47	24.2	1017.0	0
	1900	3	40	23.2	1016.5	0
29	100	4	32	22.5	1017.1	0
	700	7	37	22.4	1017.7	0
	1300	5	37	23.1	1017.9	0
	1900	3	86	21.5	1017.2	0
30	100	1	135	18.8	1017.5	0
	700	3	344	21.1	1017.9	0
	1300	5	68	24.3	1018.2	0
	1900	7	62	22.1	1017.1	0
31	100	7	67	21.7	1016.9	0
	700	9	49	21.6	1016.7	0
	1300	11	32	22.2	1015.9	0
	1900	11	23	21.2	1013.6	0
		Resultant		Mean	Mean	Total
		2	73	23.8	1018.7	166

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4
Wave Data**

Aug 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	1.28	14.3	2.34	13.5	0.28	8.9	106	2.95	12.9
	0700	0.26	8.6	0.33	6.8	0.31	8.2	106	0.38	8.3
	1300	0.20	4.4	0.28	7.8	0.35	7.6	0	0.44	7.3
	1900	0.27	5.7	0.29	9.9	0.30	7.6	66	0.37	6.1
2	0100	0.20	5.1	0.29	9.9	0.30	9.8	102	0.37	9.9
	0700	0.30	6.0	0.34	15.1	0.34	9.8	106	0.40	9.5
	1300	0.28	5.9	0.31	15.1	0.31	15.7	72	0.38	9.5
	1900	0.25	6.0	0.33	14.3	0.29	15.7	90	0.41	7.0
3	0100	0.25	5.5	0.31	9.2	0.31	15.7	98	0.38	5.3
	0700	0.32	5.3	0.35	14.3	0.37	5.0	104	0.43	5.6
	1300	0.29	6.0	0.35	8.3	0.38	8.2	106	0.45	6.0
	1900	0.29	5.7	0.40	7.8	0.43	7.6	108	0.54	6.5
4	0100	0.41	6.6	0.47	6.6	0.45	6.6	110	0.55	6.3
	0700	0.30	5.6	0.46	6.8	0.46	7.1	106	0.60	6.6
	1300	0.39	7.2	0.49	7.0	0.44	7.1	108	0.60	7.2
	1900	0.41	5.9	0.59	4.1	0.53	6.2	110	0.72	6.5
5	0100	0.39	6.3	0.54	4.2	0.47	4.2	42	0.65	4.5
	0700	0.25	4.6	0.47	7.4	0.46	7.6	104	0.61	6.5
	1300	0.42	6.1	0.65	3.9	0.52	3.9	58	0.76	3.8
	1900	0.32	7.8	0.58	7.8	0.53	7.6	104	0.71	7.6
6	0100	0.36	7.4	0.48	7.8	0.44	7.1	108	0.58	7.6
	0700	0.21	5.9	0.43	7.2	0.43	7.6	84	0.52	6.6
	1300	0.34	6.4	0.45	6.7	0.38	7.0	0	0.52	6.9
	1900	0.23	5.6	0.40	6.5	0.40	7.1	108	0.49	6.6
7	0100	0.32	7.2	0.43	7.2	0.42	7.6	84	0.48	7.8
	0700	0.26	7.2	0.51	7.4	0.48	7.6	76	0.61	7.2
	1300	0.43	8.6	0.61	7.4	0.50	8.2	106	0.68	8.3
	1900	0.28	7.8	0.56	8.3	0.49	8.2	106	0.62	8.1
8	0100	0.40	7.4	0.60	7.6	0.58	7.1	80	0.68	8.6
	0700	0.35	8.1	0.63	8.3	0.59	7.6	88	0.82	7.0
	1300	0.44	8.6	0.69	7.8	0.69	7.6	84	0.70	8.3
	1900	0.37	8.6	0.63	8.3	0.65	8.2	76	0.74	8.1
9	0100	0.40	8.3	0.71	9.2	0.69	8.2	84	0.79	8.1
	0700	0.35	9.2	0.56	9.5	0.62	8.9	96	0.72	10.3
	1300	0.39	8.6	0.58	8.9	0.60	9.8	104	0.63	9.2
	1900	0.35	9.2	0.50	9.2	0.50	8.9	104	0.60	8.6
10	0100	0.29	8.9	0.48	8.9	0.51	9.8	102	0.56	9.2
	0700	0.29	9.2	0.43	9.5	0.44	9.8	104	0.50	9.5
	1300	0.27	9.2	0.46	9.2	0.44	8.9	74	0.51	8.9
	1900	0.43	7.4	0.59	9.2	0.55	8.9	106	0.74	4.0

**Table 4
Wave Data (continued)**

Aug 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.38	4.1	0.61	8.9	0.63	8.9	76	0.80	4.1
	0700	0.35	6.3	0.52	10.7	0.52	8.9	74	0.69	11.2
	1300	0.34	10.7	0.55	9.2	0.57	8.9	76	0.68	8.3
	1900	0.42	8.6	0.64	8.6	0.62	8.9	106	0.70	8.6
12	0100	0.39	5.6	0.64	8.3	0.64	8.9	78	0.74	8.6
	0700	0.51	5.3	0.80	11.2	0.69	10.8	104	0.86	11.7
	1300	0.59	8.9	0.89	8.6	0.80	3.9	92	1.02	3.8
	1900	0.71	7.8	0.90	4.2	0.80	4.4	136	1.07	4.2
13	0100	0.74	5.4	0.85	5.5	0.89	5.9	106	1.14	5.2
	0700	0.68	5.6	0.80	6.1	0.80	5.9	120	0.94	5.5
	1300	0.56	6.3	0.75	7.0	0.77	7.6	88	0.93	6.3
	1900	0.57	7.0	0.68	7.0	0.66	8.2	106	0.88	7.0
14	0100	0.69	5.4	1.01	5.7	1.16	6.6	48	1.27	5.6
	0700	0.84	6.1	1.15	6.5	1.11	7.1	52	1.20	8.1
	1300	0.59	7.2	0.92	7.0	0.96	7.6	0	1.02	7.6
	1900	0.61	6.8	0.87	7.0	0.76	7.1	50	0.98	6.1
15	0100	0.42	5.6	0.67	6.6	0.63	6.6	50	0.80	6.3
	0700	0.41	5.9	0.62	5.9	0.54	5.9	56	0.74	6.0
	1300	0.26	5.1	0.50	5.9	0.48	5.6	56	0.58	5.7
	1900	0.33	9.2	0.50	4.5	0.42	4.1	60	0.53	5.3
16	0100	0.21	5.2	0.39	8.6	0.36	9.8	104	0.44	6.6
	0700	0.29	5.5	0.41	4.5	0.38	5.6	122	0.44	5.5
	1300	0.21	5.5	0.36	4.9	0.35	4.8	62	0.40	5.4
	1900	0.25	5.4	0.35	5.4	0.33	5.3	128	0.38	5.2
17	0100	0.19	5.3	0.31	9.2	0.31	8.9	106	0.35	9.2
	0700	0.27	9.2	0.38	8.9	0.38	8.2	108	0.40	5.5
	1300	0.23	8.3	0.37	8.1	0.35	8.2	106	0.44	8.6
	1900	0.31	7.2	0.41	8.6	0.38	7.6	110	0.49	7.6
18	0100	0.21	6.6	0.32	6.5	0.35	7.6	108	0.40	6.8
	0700	0.32	4.9	0.39	7.6	0.41	15.7	90	0.46	7.6
	1300	0.23	8.1	0.32	15.1	0.36	15.7	80	0.41	8.3
	1900	0.30	7.2	0.37	15.1	0.41	15.7	106	0.45	13.5
19	0100	0.26	6.1	0.37	15.1	0.39	15.7	98	0.43	15.1
	0700	0.25	14.3	0.37	14.3	0.40	13.6	84	0.42	14.3
	1300	0.24	15.1	0.38	15.1	0.42	15.7	78	0.45	8.1
	1900	0.29	14.3	0.41	14.3	0.40	13.6	84	0.49	14.3
20	0100	0.32	7.8	0.48	13.5	0.42	13.6	102	0.55	14.3
	0700	0.35	7.6	0.52	7.6	0.49	7.6	106	0.61	7.6
	1300	0.36	7.6	0.56	14.3	0.44	13.6	106	0.64	7.4
	1900	0.36	4.2	0.69	12.9	0.64	13.6	102	0.78	4.5

**Table 4
Wave Data (concluded)**

Aug 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.38	5.0	0.67	4.8	0.65	7.6	66	0.79	6.0
	0700	0.31	4.9	0.64	5.6	0.68	7.6	74	0.79	6.5
	1300	0.35	13.5	0.58	12.9	0.60	7.6	68	0.70	7.8
	1900	0.25	12.9	0.56	7.6	0.58	7.6	74	0.63	7.8
22	0100	0.37	8.1	0.61	8.3	0.62	7.6	104	0.70	8.1
	0700	0.36	5.6	0.59	12.9	0.64	8.2	84	0.67	8.6
	1300	0.43	8.3	0.59	7.8	0.58	8.2	104	0.62	8.1
	1900	0.28	5.6	0.49	7.2	0.51	8.2	82	0.55	8.1
23	0100	0.36	8.9	0.47	12.2	0.51	8.2	78	0.57	8.9
	0700	0.24	5.4	0.47	8.9	0.52	8.2	68	0.57	7.6
	1300	0.43	6.6	0.53	8.6	0.58	8.9	84	0.58	9.2
	1900	0.33	5.6	0.55	9.5	0.52	8.9	104	0.65	8.9
24	0100	0.34	8.1	0.45	8.9	0.50	8.9	72	0.58	8.3
	0700	0.22	5.1	0.42	8.9	0.45	8.9	102	0.49	8.6
	1300	0.29	8.1	0.38	8.6	0.47	8.9	68	0.41	8.3
	1900	0.21	8.6	0.35	8.9	0.36	8.2	82	0.45	8.3
25	0100	0.22	8.6	0.38	8.6	0.35	8.2	66	0.44	8.1
	0700	0.29	3.7	0.51	8.1	0.38	8.2	102	0.54	8.3
	1300	0.18	11.7	0.33	8.3	0.31	8.2	100	0.39	8.3
	1900	0.21	8.3	0.37	3.3	0.29	8.2	100	0.43	8.1
26	0100	0.17	12.2	0.34	7.8	0.31	8.2	102	0.41	8.1
	0700	0.17	8.3	0.28	8.6	0.26	8.2	90	0.38	12.2
	1300	0.16	12.2	0.30	11.7	0.29	12.0	70	0.36	11.7
	1900	0.21	12.2	0.35	11.7	0.32	12.0	58	0.38	12.2
27	0100	0.15	11.7	0.32	11.7	0.34	10.8	62	0.36	10.7
	0700	0.23	10.7	0.37	10.7	0.35	10.8	56	0.37	10.3
	1300	0.16	11.2	0.36	10.7	0.39	10.8	60	0.41	9.9
	1900	0.27	10.7	0.39	10.7	0.37	10.8	62	0.43	10.7
28	0100	0.16	9.9	0.38	9.5	0.40	9.8	66	0.47	10.7
	0700	0.33	17.1	0.40	9.5	0.38	9.8	92	0.44	9.2
	1300	0.26	16.0	0.45	15.1	0.46	15.7	94	0.56	15.1
	1900	0.48	16.0	0.59	14.3	0.53	15.7	96	0.60	15.1
29	0100	0.35	13.5	0.57	13.5	0.59	13.6	90	0.75	14.3
	0700	0.71	14.3	1.00	14.3	0.84	13.6	94	1.11	14.3
	1300	0.73	13.5	1.00	12.9	1.03	13.6	94	1.21	12.2
	1900	0.80	12.9	0.96	12.9	0.99	13.6	100	1.16	14.3
30	0100	0.65	13.5	0.89	14.3	0.96	13.6	100	1.10	13.5
	0700	1.04	16.0	1.09	14.3	1.26	13.6	102	1.34	14.3
	1300	0.83	12.9	0.96	11.7	1.05	12.0	104	1.21	12.9
	1900	0.92	11.7	1.10	10.7	1.06	15.7	110	1.35	15.1
31	0100	0.85	14.3	1.11	11.2	1.13	13.6	102	1.29	11.2
	0700	1.22	13.5	1.50	12.9	1.54	15.7	108	1.80	15.1
	1300	1.15	15.1	1.99	15.1	2.01	6.6	76	2.32	15.1
	1900	1.37	14.3	2.30	15.1	2.40	15.7	90	2.74	15.1
	Mean	0.40	8.4	0.59	9.3	0.56	9.3	87	0.70	8.7
	Std dev	0.23	3.2	0.34	3.1	0.31	3.1	23	0.41	2.9

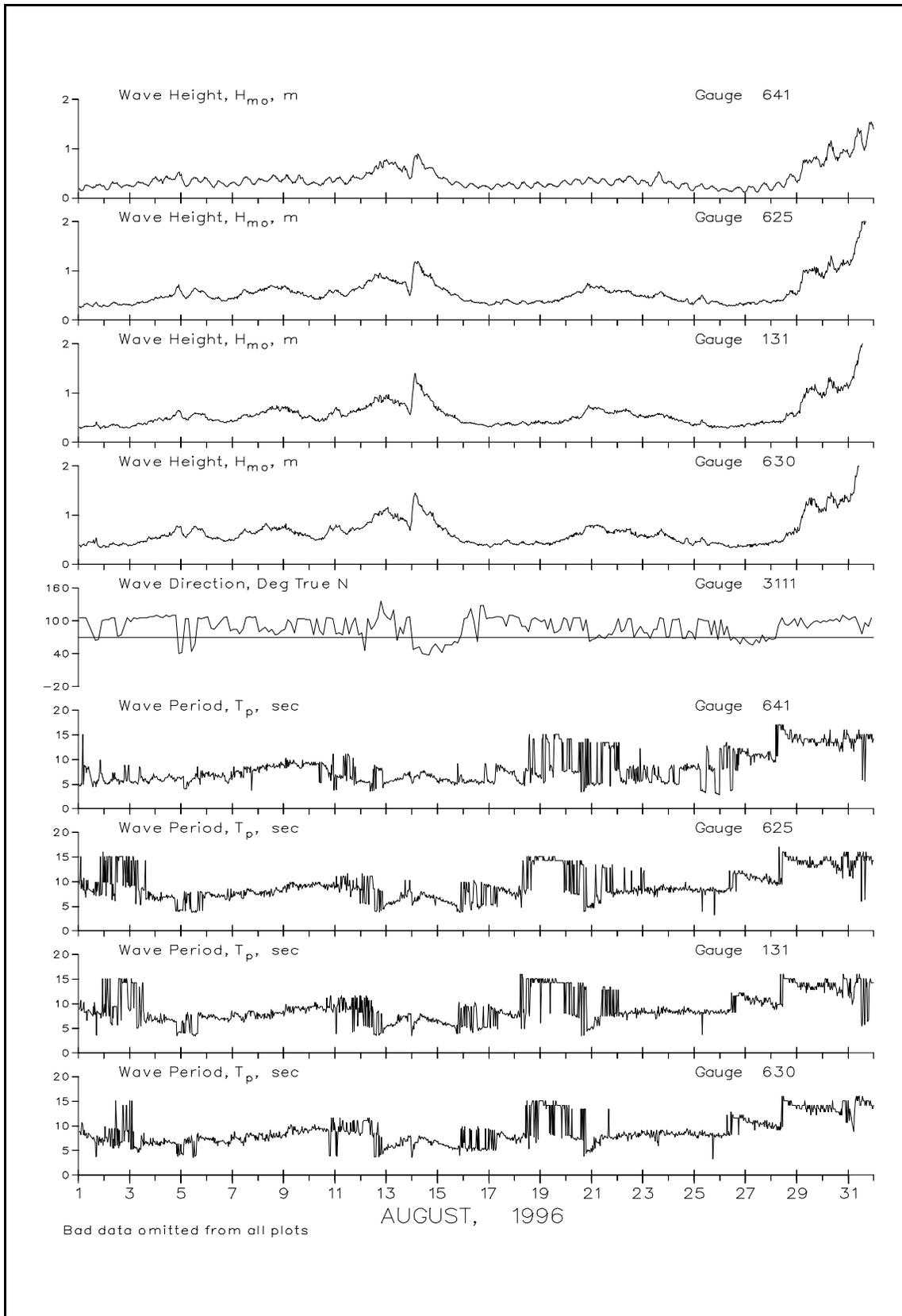


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

AUGUST 1996																	
Cross Long					Cross Long					Cross Long							
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	4	1	4	234	1300	9	14	17	192		22	100	-4	2	5	90
	700	2	-5	6	317		1900	-7	22	23	141		700	-3	0	4	52
	1300	-4	-1	5	51	12	100	-3	18	19	147		1300	7	-7	10	300
	1900	-14	-10	19	35		700	-2	9	10	140		1900	-3	0	5	57
2	100	1	0	1	242		1300	5	-1	5	271	23	100	-4	-5	7	18
	700	-9	-3	11	51		1900	-4	0	5	72		700	-6	-6	10	28
	1300					13	100	1	6	6	165		1300	4	-16	18	326
	1900						700	-2	11	11	143		1900	-6	-1	7	55
3	100	inoperative					1300	-1	3	4	129	24	100	1	-3	4	333
	700						1900	-6	11	13	127		700	-2	0	3	53
	1300	0	5	5	150	14	100	-5	18	19	141		1300	-1	-4	6	360
	1900	-3	14	15	146		700	-9	33	34	143		1900	-2	-3	5	23
4	100	-7	19	21	136		1300	-7	24	25	141	25	100	-1	0	2	71
	700	-8	21	22	136		1900	-8	7	11	111		700	-3	4	6	116
	1300	-5	12	14	133	15	100	-4	8	10	127		1300	-2	-1	3	43
	1900	-8	27	29	143		700	-6	19	20	141		1900	-1	2	3	116
5	100	-5	12	13	135		1300	-10	11	16	115	26	100	-5	13	14	137
	700	-4	11	13	135		1900	-4	2	5	89		700	-5	23	24	144
	1300	-4	24	25	148	16	100	-4	2	5	91		1300	4	0	4	254
	1900	0	12	12	154		700	-5	9	10	126		1900	-4	4	7	111
6	100	-3	-1	5	42		1300	2	4	5	189	27	100	-1	-1	3	29
	700	-4	4	7	107		1900	-5	4	8	105		700	-6	15	17	137
	1300	inoperative				17	100	-5	0	6	63		1300	inoperative			
	1900	-2	-13	15	352		700	-3	12	13	143		1900	-1	2	2	111
7	100	-3	0	4	76		1300	-5	8	10	127	28	100	-5	-1	6	47
	700	-3	7	8	127		1900	-1	2	3	112		700	-6	5	9	106
	1300	-1	0	2	75	18	100	-4	6	8	120		1300	inoperative			
	1900	-4	9	10	131		700	-3	3	5	106		1900	0	8	8	155
8	100	-3	0	4	71		1300	14	-2	14	262	29	100	-4	11	12	136
	700	-4	1	5	81		1900	-2	3	4	122		700	-5	26	27	147
	1300	3	-15	17	329	19	100	-4	7	9	125		1300	3	6	7	184
	1900	-6	-7	11	23		700	-6	2	7	87		1900	0	6	6	147
9	100	0	3	3	142		1300	8	-3	9	275	30	100	4	1	4	243
	700	-2	7	8	136		1900	-3	7	8	132		700	7	-14	17	314
	1300	-5	-4	8	34	20	100	-5	7	9	117		1300	1	1	2	199
	1900	1	-5	6	333		700	-2	10	11	143		1900	5	-6	9	307
10	100	0	-2	3	5		1300	0	6	6	156	31	100	4	6	7	194
	700	0	0	0			1900	0	9	9	159		700	6	0	6	256
	1300	-7	-7	11	22	21	100	-2	4	5	127		1300	5	28	29	169
	1900	-2	-2	4	28		700	-1	7	7	146		1900	4	25	26	170
11	100	-5	-4	7	29		1300	6	-1	7	272						
	700	-5	29	29	148		1900	-5	1	7	82						

KEY:

+cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Aug 1996												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	15	-15	22	25	5	-11	12	7	South	9	N	
2	13	-20	23	13	0	3	3	154	North	9	N	
3	-3	-51	51	337	0	-11	11	340	no observation			
4	-2	47	47	163	1	-13	13	343	no observation			
5	-6	38	39	169	-4	7	8	189	North	0		
6	-3	11	11	174	10	5	11	98	North	14	N	
7	-3	11	11	174	-1	10	10	250	North	11	N	
8	-3	12	12	174	-3	6	7	250	North	43	N	
9	4	-16	17	354	10	-14	17	17	South	49	N	
10	0	0	0		5	19	20	70	South	4	N	
11	-11	76	77	169	0	0	0		North	27	N	
12	-6	18	20	179	0	0	0		North	9	N	
13	6	-30	31	351	24	-41	47	11	South	82	N	
14	-9	44	44	171	-4	41	41	166	North	55	N	
15	-8	32	33	174	-6	21	22	177	North	46	N	
16	2	16	16	154	-2	8	8	171	North	2	S	
17	6	-15	16	2	0	-3	3	349	South	3	N	
18	3	-10	11	354	3	-9	9	2	South	11	N	
19	-24	19	30	250	7	-9	12	17	South	11	N	
20	-8	32	33	174	7	7	9	70	North	40	N	
21	-7	16	18	182	8	8	11	70	North	18	N	
22	0	0	0		1	-18	18	343	no observation			
23	2	-5	5	2	3	-11	12	357	South	32	N	
24	10	-9	13	29	7	-18	19	2	South	12	N	
25	1	8	8	154	0	15	15	160	North	15	S	
26	0	55	55	160	2	4	4	133	North	5	S	
27	19	19	27	115	5	5	7	115	North	14	S	
28	0	23	23	160	0	4	4	160	North	3	S	
29	-9	30	32	177	0	0	0		North	3	S	
30	-3	19	19	169	12	-41	42	357	South	9	N	
31	5	23	23	149	10	-68	68	349	South	8	N	

KEY:
+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Aug 1996							
Day	Time	Wave Approach		Width of Surf Zone,m	Water Characteristics at Pier End		
		Angle at Pier End deg from True N	Primary Secondary		Temp.,C	Density g/cc	Secchi Vis.,m
1	0630	90	110	2	18.1	1.0241	2.1
2	0645	100		3	22.8	1.0228	6.4
3	0620	130		24	23.0	1.0220	7.3
4	0630	130		37	23.3	1.0208	8.8
5	0615	60		40	24.2	1.0182	4.6
6	0555	80		44	23.6	1.0178	6.4
7	0610	80		32	24.2	1.0177	5.5
8	0520	90	50	35	21.9	1.0178	3.7
9	0710	100	70	29	25.3	1.0172	2.4
10	0955	80	40	29	25.0	1.0196	4.9
11	1100	35	85	30	25.3	1.0167	3.0
12	0610	90		38	25.0	1.0154	4.3
13	0600	95		30	25.3	1.0211	2.7
14	0600	50		67	24.7	1.0200	2.1
15	0600	40	75	41	23.6	1.0195	4.6
16	0630	90	70	12	24.2	1.0185	4.0
17	0750	95	70	6	24.7	1.0171	3.0
18	0750	95		9	26.3	1.0196	2.4
19	0630	90		15	24.7	1.0178	4.0
20	0600	95	55	29	25.8	1.0165	4.0
21	0620	70	50	30	25.6	1.0152	4.0
22	0655	120	80	27	25.0	1.0174	5.2
23	0700	95		29	24.4	1.0203	4.9
24	0810	85		29	23.1	1.0218	3.7
25	0820	30		23	24.4	1.0225	4.0
26	0640	50		8	25.3	1.0172	2.4
27	0620	90	70	21	24.7	1.0173	3.0
28	0550	85	30	11	25.0	1.0202	3.7
29	0738	90	50	43	25.6	1.0200	3.0
30	0638	100		59	25.3	1.0194	3.4
31	0645	90		110	25.6	1.0186	3.0

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

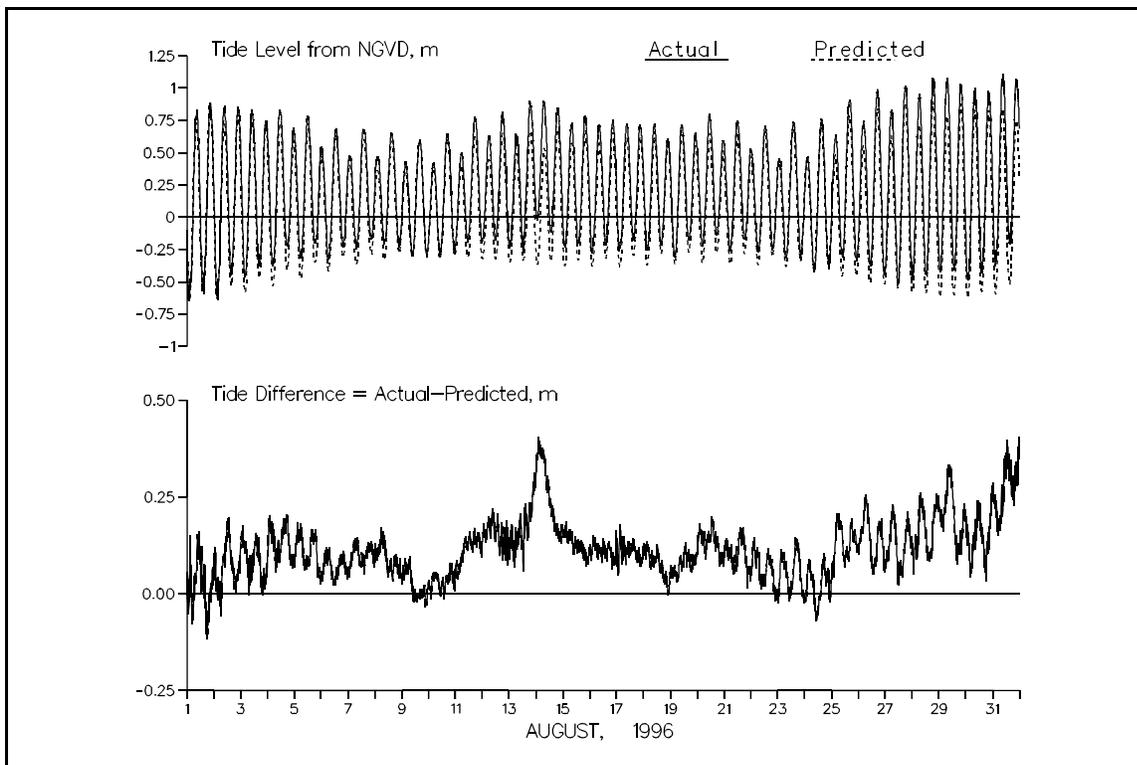


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

AUG 1996 Tide Levels															
Day	High		Day	Low		Mean	Range	Day	High		Day	Low		Mean	Range
	Time	m		Time	m				m	m		Time	m		
1	0906	0.83	1	0148	-0.64	0.10	1.48	16	2054	0.76	16	1430	-0.22	0.27	0.98
1	2100	0.89	1	1454	-0.60	0.14	1.48	17	0848	0.73	17	0154	-0.27	0.23	0.99
2	0948	0.87	2	0324	-0.64	0.14	1.50	17	2048	0.72	17	1506	-0.18	0.26	0.90
2	2148	0.86	2	1542	-0.46	0.21	1.31	18	0936	0.72	18	0330	-0.26	0.23	0.98
3	1006	0.83	3	0354	-0.47	0.19	1.30	18	2136	0.61	18	1548	-0.22	0.20	0.83
3	2312	0.75	3	1648	-0.38	0.19	1.13	19	1042	0.72	19	0418	-0.31	0.21	1.03
4	1106	0.83	4	0436	-0.38	0.24	1.22	19	2218	0.65	19	1654	-0.18	0.23	0.83
4	2324	0.70	4	1806	-0.23	0.22	0.93	20	1112	0.80	20	0500	-0.23	0.28	1.03
5	1154	0.78	5	0600	-0.32	0.23	1.10	20	2324	0.60	20	1736	-0.14	0.22	0.74
6	0018	0.55	5	1818	-0.21	0.16	0.76	21	1200	0.75	21	0542	-0.27	0.25	1.02
6	1318	0.69	6	0618	-0.33	0.19	1.02	22	0012	0.53	21	1818	-0.17	0.18	0.71
7	0106	0.48	6	1942	-0.23	0.14	0.71	22	1300	0.71	22	0636	-0.28	0.21	0.99
7	1342	0.68	7	0736	-0.25	0.23	0.93	23	0124	0.46	22	1930	-0.26	0.11	0.71
8	0218	0.47	7	2048	-0.17	0.16	0.64	23	1354	0.74	23	0724	-0.32	0.21	1.06
8	1454	0.66	8	0818	-0.21	0.22	0.87	24	0300	0.47	23	2030	-0.31	0.10	0.78
9	0306	0.44	8	2136	-0.24	0.10	0.67	24	1506	0.76	24	0854	-0.42	0.17	1.19
9	1554	0.60	9	1006	-0.31	0.15	0.91	25	0348	0.64	24	2148	-0.40	0.14	1.04
10	0430	0.42	9	2230	-0.31	0.07	0.74	25	1606	0.91	25	0948	-0.31	0.29	1.22
10	1712	0.65	10	1018	-0.31	0.18	0.96	26	0436	0.74	25	2224	-0.34	0.22	1.08
11	0518	0.50	10	2318	-0.29	0.12	0.80	26	1718	0.99	26	1106	-0.38	0.29	1.37
11	1730	0.78	11	1054	-0.20	0.28	0.98	27	0536	0.84	26	2330	-0.45	0.20	1.29
12	0548	0.63	11	2342	-0.20	0.22	0.84	27	1830	1.02	27	1130	-0.53	0.27	1.55
12	1800	0.82	12	1200	-0.18	0.30	1.00	28	0648	0.96	28	0024	-0.48	0.23	1.43
13	0612	0.64	13	0012	-0.24	0.21	0.89	28	1900	1.08	28	1254	-0.45	0.31	1.53
13	1836	0.90	13	1230	-0.28	0.36	1.18	29	0724	1.07	29	0118	-0.43	0.32	1.50
14	0700	0.90	14	0112	-0.02	0.43	0.93	29	1818	1.03	29	1300	-0.41	0.30	1.45
14	1918	0.84	14	1348	-0.12	0.36	0.96	30	0736	1.00	30	0100	-0.49	0.26	1.50
15	0754	0.73	15	0142	-0.24	0.25	0.97	30	1912	0.98	30	1330	-0.43	0.28	1.41
15	2000	0.79	15	1406	-0.21	0.28	1.00	31	0812	1.11	31	0136	-0.38	0.37	1.49
16	0824	0.72	16	0212	-0.28	0.22	1.00								

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using either a Trimble 4000 GPS or a Geodimeter 140-T self-tracking total station for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in July 1996 and the survey(s) in August 1996 on profile line 188, located 517 m south of the pier.

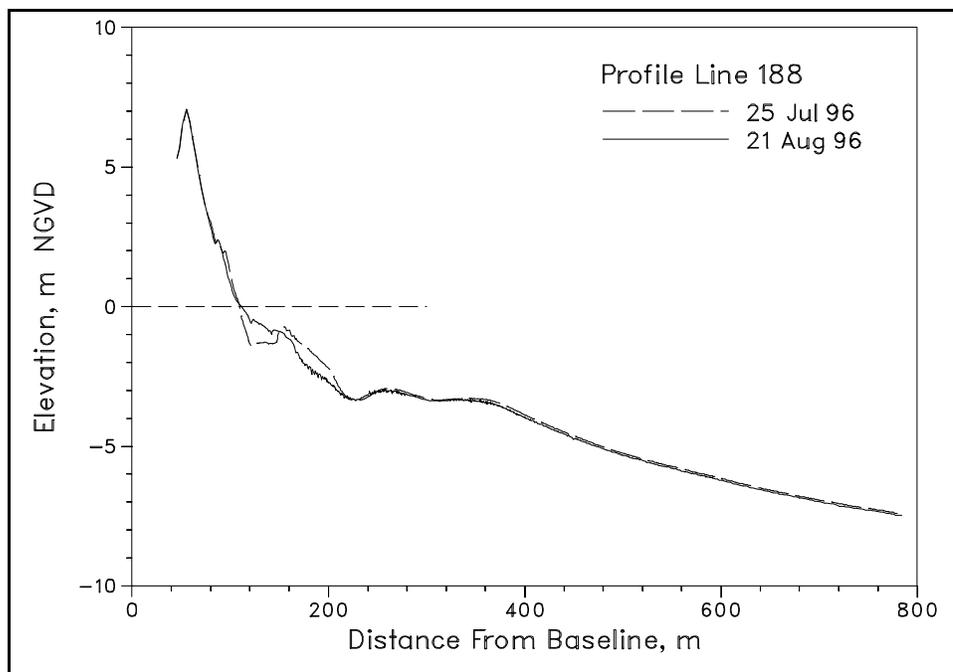


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1996. Cross-hatched areas indicate changes to the annual envelope which occurred in August.

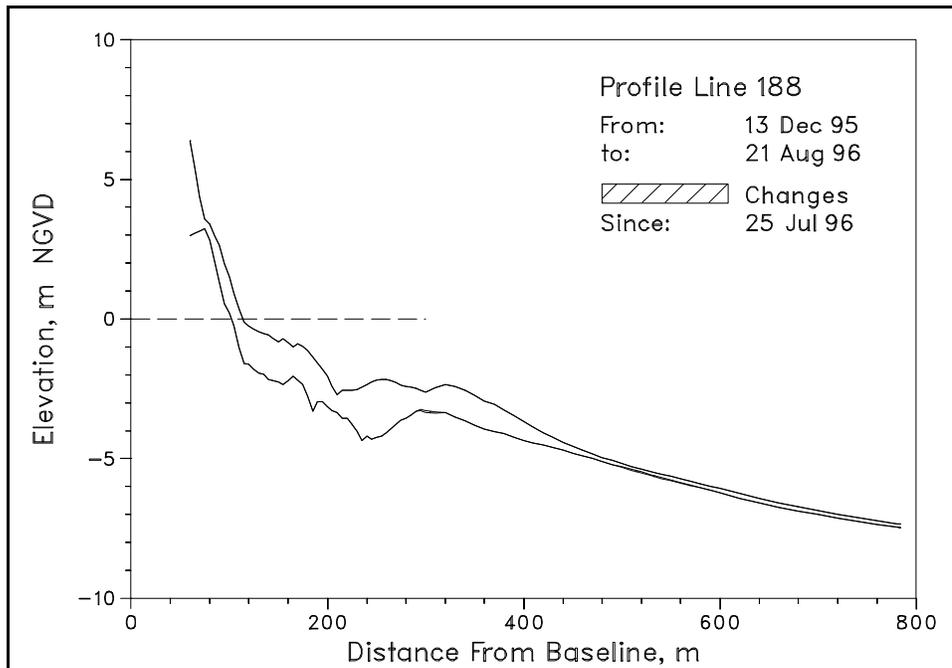
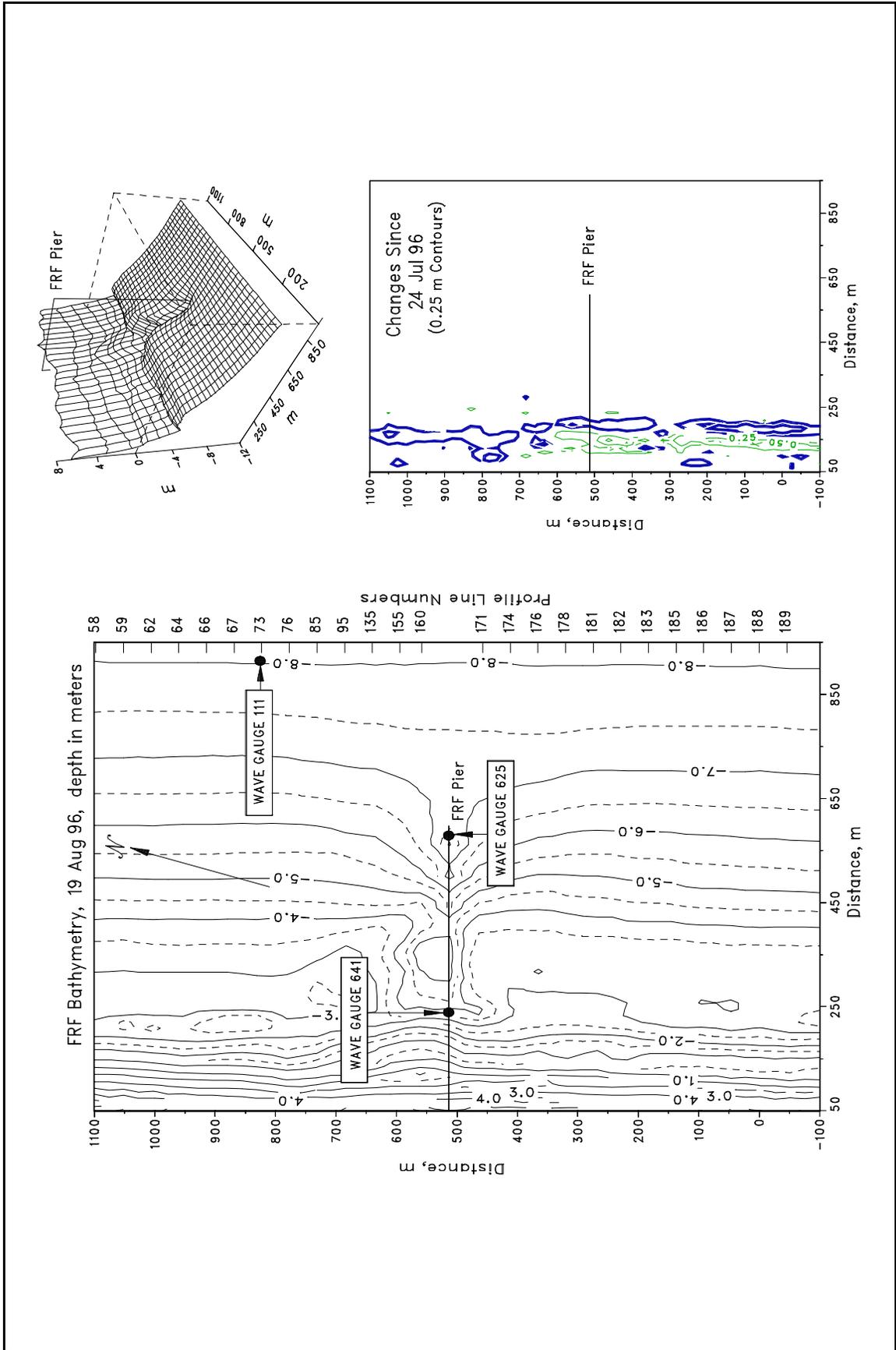


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 19 August. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
31 Aug (1034)	02 Sep (0242)

B. Storm Synopsis.

31Aug-02Sep Northeasterly winds were funneled between hurricane Eduoard (which remained 400km offshore) and a high pressure system to the north. Maximum onshore winds (NE) reached 12 m/s at 1634 EST on 31 August. The maximum H_{mo} , at gauge 630, reached 3.4 m ($T_p=13.5$ s) at 1142 EST on 01 September. There was no precipitation.